(e.g. electronic toll and traffic management (ETTM)).

To the maximum possible extent, the JPO has emphasized the appropriate use of the first two alternatives. However, dedicated spectrum may be needed to support critical public safety and warning services where reliability, accessibility and liability are primary issues.

III SpecificIssues Relating to Public Safety Applications of ITS User Services

A. Interoperability Issues

1. Definition of Public Safety. The FCC proposal to adopt the PSWAC definitions for public safety will be well suited for the ITS program. State and local DOTs as well as highway maintenance organizations will continue to be considered as public safety organizations. More importantly, under these new definitions, private organizations operating as ITS independent service providers (ISPs) will be considered as Public Safety Support Providers when authorized by public safety organizations to offer safety-related ITS services. Examples of these services include processing automated mayday requests or offering route guidance to emergency vehicles.

2. Interoperablility definition and needs.

The issue of wireless communications interoperability for Intelligent Transportation Systems should be focused on two major categories:

Interagency Interoperability: Interoperability among Traffic Management Centers (TMCs), Emergency Management Centers, and deployed public safety and public service personnel is needed. These agencies need connectivity with all other public safety agencies that can provide or need access to traffic flow, incident detection and response, emergency response and safety-related information. In most cases, multiple centers are in operation within a geographical region and inter-jurisdictional cooperation is necessary.

ITS Device Interoperability: Public safety mobile units need direct access to ITS related information on a nationwide basis using either the primary radio system deployed by public safety organizations or by procuring multiple communications equipment. The key issue is how public safety field units will exchange data with numerous ITS information sources without purchasing different equipment for each system for each region of operation.

2.1 Interagency Interoperability

Interoperability between traffic management centers and other public safety agencies will be a mutually beneficial relationship. Traffic management centers will benefit by receiving real time traffic and incident information from public safety mobile units. Public safety and public service agencies will use ITS data to improve incident detection/response time and to aid in law enforcement. Public Safety agencies will also benefit from being able to make traffic control recommendations during incidents.

Traffic management and other ITS user services will often require interoperability across city, county, and state boundaries. Safety-related services involving commercial vehicle operations may involve international boundaries (Canada and Mexico). Concepts such as block frequency assignments to states for public safety would greatly impede finding solutions to interagency interoperability for ITS and public safety.

One of the goals of the traffic management centers is to improve traffic flow and reduce congestion. In order to meet this goal, the traffic control agencies need real-time data from incidents that will disrupt normal traffic patterns. While some of this data can be provided by ITS devices (such as video detection units), an additional source will be data supplied by field deployed public safety units. A consistent, automated path for funneling this information from the field to the traffic management centers is needed.

Other public safety organizations will benefit if relevant information collected by the traffic management centers can be forwarded to the agencies responsible for incident and emergency response. This will allow the responding agencies to maximize the efficiency and expediency of their response.

A key issue is: do public safety field units need a direct communication channel with traffic management centers and what is the most effective means of transferring this information? Field units need to provide incident data to the traffic management centers. Traffic management centers need to provide information on incidents, traffic control decisions, road hazards etc., to public safety field units.

The following sections detail the ITS user services that would benefit from day-to-day interoperability with public safety communications systems.

Automatic Collision Notification; Driver and Personal Security: These systems will be used to notify monitoring organizations that an incident or collision has occurred. A RF data channel is needed from private vehicles and public transit vehicles to a network access point for the monitoring organization. If a public safety response is warranted, the appropriate agencies must be notified. Since the vehicle could be moving during the incident, a RF data channel is needed to provide incident location information to the responding public safety units. The key requirement for this process will be an automated, electronic transfer function for routing the data from the monitoring agency to the public safety agencies. The data must be in a format that the public safety agencies can immediately transmit to their field units.

Enroute Driver Information; Incident Detection: These systems will be used to inform drivers with in-vehicle ITS equipment of relevant traffic conditions. Traffic management agencies need access to real time incident, weather, and traffic data so drivers can be notified. A source of information will be field reports over voice and data channels from public safety units. Network connections will be used to transfer the field data to traffic management centers. Drivers of public safety vehicles will need to receive the notifications expeditiously over various communications links.

Emergency Vehicle Route Guidance: This service will have a function similar to Enroute Driver Information. In order for the system to be successful, accurate, real time incident data must be available to traffic management agencies, and efficient routing information must be provided to drivers of public safety vehicles.

Emergency Vehicle Signal Priority; Priority Treatment for Transit: This service will enable adjustments to be made to traffic control devices to maximize the efficiency of the transportation systems, minimize response time by emergency service providers, and aid in law enforcement. Traffic management will need real-time incident data in a format that can be processed by traffic control decision-making systems. Traffic management agencies will also collect requests for traffic control that public safety vehicles and transit vehicles will need. Devices that allow direct traffic signal pre-emption from a public safety vehicle may be required.

Public Travel Security: Alarm systems installed in transit stations, bus stops, and public transit vehicles will be monitored by private or public agencies depending on the location and scope of the system. Private agencies will need a communications path to notify public safety agencies when assistance is required.

On-board Safety Monitoring: Data monitoring and communications systems onboard commercial vehicles collect safety data pertaining to critical vehicle components, condition of the cargo, and the fitness of the driver. Law enforcement officials need to be notified of the vehicle, its location, and the nature of any safety violation requiring attention.

The following sections detail the ITS user services that would benefit from mutual aid interoperability with public safety communications systems.

Route Guidance and Enroute Driver Information: Incident liaison officers will need to provide incident data to the traffic management agencies. The incident commander may make recommendations on data that drivers should receive. RF data, voice, and video channels will be needed to connect the liaison officer to the traffic management center.

Incident Detection and Management: Data, voice, and video connectivity via RF channels are required between the incident liaison officer and the TMC. The TMC will be making decisions about wide area traffic flow while the incident commander makes decisions at the site of the incident. These decisions need to be closely coordinated.

Traffic Control: Data and voice RF connectivity are required between the incident liaison officer and the TMC. The incident commander needs to be informed of traffic control decisions made at the TMC that impact the area of operations. The incident commander also needs the ability to request specific traffic control measures be taken.

Enroute Transit Information: The incident liaison officer will need to provide incident data to the transit management centers and traffic management centers. The incident commander may make recommendations on data transmitted to transit vehicles. Voice and data channels are required between the incident liaison officer and the agency controlling transit information.

Public Transportation Management: System operators will need accurate information from the incident liaison officer to verify that management recommendations produced the desired effects. Voice and data connectivity is required. The incident commander needs the capability to dispatch these vehicles if large scale evacuations are required. This will require RF voice/data connectivity with the agency responsible for controlling these vehicles.

Public Travel Security: The incident commander may need access to data from wide spread security devices. Data connectivity is needed between the incident liaison officer and the organization monitoring the security devices.

Hazardous Materials Incident Response: The incident commander needs access to all HAZMAT data collected by the responsible monitoring organization. This will require voice/data RF connectivity between the incident commander and the agency. The incident commander will need a portable reader if the HAZMAT vehicle has HAZMAT data stored in an on-vehicle Dedicated Short Range Communications (DSRC) transponder.

International Border Crossing: DSRC systems are used to allow pre-cleared (safety status, credentials, weight etc.) commercial vehicles to proceed across international borders without stopping. Location and other pertinent information on commercial vehicles attempting to cross in violation needs to be sent to registration, fuel tax, immigration, law enforcement, customs, and state transportation agencies.

Emergency Vehicle Management (EVM): The incident commander needs full access to this system. A real time GIS display showing vehicle locations would be invaluable. Since the response will involve multiple agencies, the individual emergency vehicle tracking systems must be compatible. Data connection via an RF channel is needed to each responding agency that is utilizing an EVM system.

The following sections detail the ITS user services that would benefit from task force interoperability with public safety communications systems.

Enroute Driver Information; Route Guidance, Enroute Transit Information: Task force commanders need the ability to coordinate with the TMC responsible for sending information to drivers so that traffic flow would be routed to aid the task force operations. This will require a voice/data RF channel between the task force and the TMC.

Incident Management: Data and voice connectivity via RF channels are required between the task force commanders and the Traffic Management Center. The task force commander needs to be aware of any TMC decisions impacting the operations of the task force such as traffic flow, safety messages, traffic alerts.

Traffic Control: Data and voice RF connectivity are required between the task force commander and the TMC. The commander needs the ability to request specific traffic control measures be taken.

Public Transportation Management: System operators will need accurate information from the task force commanders to verify that management recommendations will produce the desired effects. Voice and data connectivity is required. The incident commander needs the capability to dispatch these vehicles if large scale evacuations are required. This will require RF voice/data connectivity with the agency responsible for controlling these vehicles.

Emergency Vehicle Management: Task force commanders need full access to this system. A real-time GIS display showing vehicle locations would be invaluable. Since the response will involve multiple agencies, the individual EVM systems must be compatible. Data connection via an RF channel is needed to each agency that is utilizing this system.

The following paragraph summarizes the findings of the PSWAC Interoperability Subcommittee concerning interagency interoperability issues for ITS.

For ITS services to be interoperable the following items must be addressed to achieve a high degree of interoperability: 1) Standardized ITS data formats and interfaces are required to ensure that real time incident data can be shared by multiple agencies. 2) Agencies need an automated, electronic means of sharing incident data on a day-to-day basis. 3) Agencies need to develop policies to ensure that relevant data are shared with other organizations. 4) Incident and task force commanders need full coordination capabilities with all affected traffic management centers. This will require voice/data/video connectivity over RF channels.

2.2 ITS Device Interoperability

ITS devices must be accessible to field deployed units from multiple agencies on a nationwide basis. Technology and frequency plan standards must be developed and implemented if this goal is to be reached using public safety radio systems for wide area communications. ITS communications based on one-way broadcast (likely using FM subcarrier) or DSRC transponders will require public safety vehicles to be equipped with these new systems. Efforts are underway by various organizations to standardize the protocols for reception of FM subcarrier and DSRC. If successful, single nationwide interoperable devices will be available for use by public safety personnel. Wide area communications are expected to be based on commercially available services such as cellular radio, ESMR and PCS and is expected to vary from region to region.

The key issue is how public safety field units will receive data from numerous types of ITS devices without purchasing a different receiver for each system and for each region of operation. Wide area mobile communications for ITS will be selected by the locality or the service provider offering the ITS user service. Public safety agencies have the option of installing a data interface with a TMC, transit management center, or independent service provider, and integrating the required ITS-related information onto the public safety radio systems. If these systems have interoperable modes, then ITS information can be made interoperable provided the message formats are standardized. Agencies leasing commercial wide area wireless service will likely have to lease equipment from a service provider that is offering the ITS services in the location the agency needs to operate in.

3. Interoperability Options-Common mode of operations.

Interoperability between ITS and public safety agencies and public service agencies for wide area mobile communications can be provided by the FCC adopting rules to have common communications modes and frequency bands for the agencies that operate using frequency assignments in the public safety bands. ITS services will be offered using existing commercial communications when possible. Since the commercial technology in this area is diverging into a multitude of over-the-air protocols, common modes and bands among equipment operating in the public safety bands may be the only solution to interoperability for providing ITS services for critical public safety operations.

Many new safety-related services being developed for ITS are expected to be implemented using dedicated short-range microwave communications (DSRC) that support vehicle to roadside communications via roadside readers and on-vehicle transponders. FHWA is pursuing common modes of operation and a common frequency band (5850-5925 MHz) to ensure that services using this technology are interoperable. A proposed FCC requirement that all radios being type accepted for public safety be capable of operating on designated mutual aid channels would not make sense for this class of equipment. The services intended for this technology are mixed; both safety-related and non-safety related services have been defined. Therefore the PSWAC has recommended, and FHWA agrees, that ITS pursue its own allocation. However, public safety and public service agencies are expected to use frequency assignments in ITS bands when appropriate.

B. Operational Issues

ITS represents a broad range of applications that, because of their ability to enhance performance of different public safety communities' transportation and operations, apply horizontally across many other public safety communities' requirements. It should be noted that the operational requirements for ITS are derived from the ITS National Architecture and the user services on which the architecture is based.

The relationship between ITS and public safety has several aspects including the safety of the traveler and the safety of public safety personnel performing mission related functions.

Descriptions of each ITS safety-related operational requirement :

Emergency vehicle location tracking: Wireless data communications will be used to collect position-location information and data from emergency vehicles to improve the monitoring and display of emergency vehicle locations and help dispatchers efficiently task the units that can most quickly reach an incident site.

Emergency vehicle route guidance: Route guidance information is sent via wireless data communications to direct emergency vehicles equipped with guidance and navigation displays to an incident location. Directions are provided based on real-time information collected concerning traffic conditions and road closures in developing the best route.

Emergency vehicle signal priority: Signal priority uses wireless data communications to clear traffic signals in an emergency vehicle's route. In order to facilitate speedy movement for emergency vehicles, the vehicle can (with the help of an "onboard transceiver") alter the timing of traffic signals in the immediate vicinity (via the "fixed reader" mounted beside the traffic lights) to generate a "green wave" (a series of green signal lights in the desired direction of travel).

Driver and personal security: Wireless communications will be used for user initiated distress signals for incidents ranging from mechanical breakdowns to car jackings.

Automated collision notification: Sensor technology is used to identify when a vehicle has had a collision and information is automatically sent via wireless data communications regarding location, nature, and incident severity to emergency personnel.

Enroute driver information: Wireless data communications are used to provide driver advisories conveying information about traffic conditions, incidents, construction, and weather conditions to drivers of personal, commercial, emergency, and public transit vehicles. The information may be provided by state and local authorities, transit authorities, and emergency management centers.

In-vehicle signing: Transmitters installed at critical points of a roadway are used to transmit data containing driver safety advisories and warnings on road hazards which could be displayed and/or enunciated to travelers in vehicles.

Incident detection and management: Sensor technology, digitized video and wireless data communications are used to help public officials quickly and accurately identify a variety of transportation system incidents, and to implement a response which minimizes the effects of these incidents on the movement of people and goods.

Probe data for traffic control: Continuous collection and transmission of vehicle counts, flow data, and travel times by wireless data communications incorporating position-location data provides information needed for traffic management, emergency fleet management and route guidance. This also provides state and local traffic management centers with real-time detection of obstructions due to traffic incidents and road hazards (this is a special case of the surveillance capability needed to effectively manage the transportation system).

Transit management: Wireless data communications are used to maintain position location information on transit vehicles and to transfer data between transit management centers and transit vehicles. Transit vehicles can be instructed to adjust their schedule or route to allow for incidents or bad road conditions. Within the transit vehicle, this information can also be utilized to provide automatic signage and annunciation of the next stop.

Priority treatment for transit: Identification of transit vehicles at access points of HOV lanes or at intersections can be used to provide priority treatment for these vehicles via appropriate adaptation of signal timing. This is accomplished by wireless data communications between the transit vehicle and the control signal or a transit vehicle and a traffic/transit management center that can exercise signal control.

Public Travel Security: Wireless video and data communications can be used for systems monitoring the environment in transit stations, parking lots, bus stops, and transit vehicles and generate alarms either automatically or manually as necessary. This improves security for both transit riders and operators.

Automated roadside inspections: Inspections are performed on commercial vehicles using wireless data communications allowing "real-time" access at the roadside to the safety performance records of carriers, vehicles, and drivers. This enables safety inspectors to access these records from the roadside.

Weight-In-Motion (WIM): Weight measuring equipment (fixed sensors embedded in the pavement or portable and temporarily deployable equipment) can ascertain the weight of a commercial vehicle at highway speeds to ensure the vehicle is operating within the rated safety limits. Wireless data communications systems are used to match the weight data obtained with the relevant credentials in the official database while the vehicle is in motion.

Automatic Vehicle Classification (AVC): In-pavement sensors, in conjunction with the roadside wireless data transceivers (and, perhaps, an inspection facility computer), are used to count the number of axles of a commercial vehicle for classification, and match the data with the vehicle.

International border crossing: Using automated vehicle identification (AVI), commercial vehicles are identified via wireless data transmission to a roadside reader and matched to its Pre-cleared credentials, allowing the vehicle to proceed without stopping. This service enables the carriers to Pre-clear vehicles at international border crossings. Automating this process implies cooperation of registration, fuel tax, immigration, safety enforcement, and customs agencies, as well as the state transportation agencies.

Electronic clearance: A wireless data communications system would be used to identify a commercial vehicle and its electronic credentials would be verified automatically while the vehicle is traveling past the roadside reader at highway speeds. This would allow commercial vehicles to travel across state borders without being stopped for verification of paperwork and permits regarding fuel usage and tax, registration, safety clearance, etc. Combined with the networking infrastructure, which would connect roadside readers to central databases and administration centers, this service will facilitate state tax report preparation, auditing, and insurance requirements.

On-board safety monitoring: Safety data is provided to enforcement personnel, carriers, transit authorities, and drivers to review the safety status of a commercial vehicle, its cargo, and its operator, over a wireless data communications link as the vehicle passes the roadside reader while traveling at highway speeds. Safety conditions of the vehicle and the driver including the condition of critical vehicle components such as brakes, tires, and lights, and sensing unsafe conditions such as shifts in cargo while the vehicle is in operation would be stored as data on the vehicle, and interrogated using wireless data communications from the roadside.

Hazardous materials incident response: The safety of shipments of hazardous materials is enhanced by providing enforcement and response teams information from the vehicle via wireless data communications on the nature and location of any incident, and the type of material involved in order to enable safe and efficient response.

Collision avoidance: Radar is used to provide crash warnings and some degree of vehicle control for lane changes, road departures, and potential or impending collisions. It will help reduce the number of longitudinal and lateral collisions involving two or more vehicles, and crashes involving a single vehicle leaving the roadway.

Intersection Collision Avoidance: Drivers are warned of imminent collisions when approaching or crossing an intersection that has traffic control (e.g., stop signs or traffic signals). This application uses wireless data communications at the various arms of an intersection to sense the speed and direction of passing vehicles, which in turn, is coordinated by a roadside processor (or master reader for that intersection). Appropriate messages are dynamically transmitted to vehicles warning them of a potential collision.

Safety readiness: Radar equipment onboard the vehicle will be used to detect unsafe road conditions, such as bridge icing and standing water on a roadway, and provide warnings to the driver.

Pre-crash restraint deployment: Radar identifies the velocity and direction of vehicles and objects involved in a potential crash. Responses include tightening lap-shoulder belts, arming and deploying air bags at an optimal pressure, and deploying roll bars.

Automated highway system (AHS) check-in: Automated check-in using wireless data communications between the roadside and the vehicle at the entrance of (AHS) lanes will be used to examine lane-worthiness of a vehicle by verifying qualifying credentials for the vehicle, driver and carrier on their safety ratings and status. This ensures that both the driver and vehicle have passed the necessary safety checks to travel on automated highways.

Highway-rail intersection safety: Vehicle Proximity Alerting Systems (VPAS) will use wireless communications to provide warning messages to vehicles concerning the approach of trains at highway-rail intersections.

C. Technology Issues.

Most of the comments solicited in this section of the docket pertain to conventional land mobile communications with an emphasis on increasing capacity by implementing technology that results in more equivalent voice channels than current systems. For wide area communications, the issue for ITS is how to integrate ITS data onto the public safety communications system that the public safety community feels is best for its primary mission.

In terms of new technology, an additional area of importance to ITS are the various short-range microwave (DSRC) technologies. Many of the new safety-related ITS features previously discussed can be implemented with this technology, and several operational tests are in progress. Some of these systems use modulations considered relatively inefficient (such as ASK and FSK), However, the end result is a very reliable in-vehicle transponder that is extremely inexpensive, which results in market penetrations at levels where great benefits to surface transportation are realized. Despite the simple modulations used, spectral efficiency is actually quite good since required communications distances are very short (vehicle to roadside), frequency reuse factors are extremely high, and the technology is amenable to spectrum sharing with other services.

D. Spectrum Allocation

At this point in the ITS program, it hasn't been critical to know exactly how many MHz are required for a given function, but it has been important to identify in which frequency bands spectrum is needed . There is significant work to do through operational tests and analysis to decide exactly how many frequencies are needed by location in a deployed system. In order to be able to reduce the cost and complexity of the in-vehicle communications equipment, it is desirable that as many services as possible be provided by a single transceiver in the same frequency band.

FHWA has a 15-year authorization from NTIA (for which 12 years remain) for ITS to use 10 frequencies (5 pairs) in the new 220-222 MHz land mobile band for development and testing. These frequencies are allotted to ITS nationwide, which means that public safety and warning systems can be developed that will operate anywhere in the country on the same frequencies - simplifying the design and reducing the cost.

A consensus has been reached among the government and industry partners in the ITS program that the 5850-5925 MHz band is a good choice for dedicated short-range microwave ITS (DSRC) communications systems. FHWA has been granted authorization from NTIA for an ITS allocation in the 5.8 GHz band for a period of 15 years to do research, development and testing. This band also focuses the issue of "how much spectrum do we need." FHWA has an allocation of 75 MHz, so that there is the flexibility to assign frequencies at various locations that do not conflict with other users to facilitate spectrum sharing. This is possible since all 75 MHz is not needed at any one place.

The PSWAC recommends that ITS (a horizontal application that benefits public safety users and non public safety users alike) should have its own spectrum allocations. They recommend, and FHWA agrees that public safety agencies and public service providers are expected to request frequency assignments in bands allocated to ITS to perform public safety related functions.

INTELLIGENT TRANSPORTATION SYSTEMS:

OPERATIONAL REQUIREMENTS

The following are the sections of the PSWAC Operational Requirements Subcommittee report that address Intelligent Transportation Systems (ITS). This material was generated in large part, commented on, and edited by, the USDOT Joint Program Office for ITS. Two sections are provided here: 4.6 Intelligent Transportation Systems *[from the section on Working Group Reports], and* 5.6 Transportation *[from the section on Federal Government & Department of Defense Operational Requirements].*

4.6 Intelligent Transportation Systems (ITS)

4.6.1 Purpose. Innovative applications planned within this services may be unfamiliar to many in the public safety community especially those designed to aid in emergency vehicle response. ITS represents a broad range of applications that, because of their ability to enhance performance of different public safety communities' transportation and operations, apply horizontally across many other public safety communities' requirements. As a result, ITS-related operational requirements appear in some of the other sections of this report. It should be noted that the operational requirements for ITS defined in this section of the report are derived from the ITS National Architecture and the user services on which the architecture is based.

Many of the applications will enhance the safety of the individual traveler, and will be available to both personally owned vehicles as well as vehicles owned and operated by traditional public safety agencies. This creates an environment where spectrum use may be shared between public safety-related, and public service and non-safety related functions.

4.6.2 Introduction. The Intermodal Surface Transportation Efficiency Act was passed by Congress and approved by the President in December 1991. It formally established the Intelligent Transportation Systems (ITS) program, which seeks to apply advanced communications and computer technologies to surface transportation systems in order to decrease traffic congestion, improve safety, reduce transportation related environmental impacts, and increase productivity. Public safety goals of the Intermodal Surface Transportation Efficiency Act (ISTEA) legislation being addressed by ITS are reducing the frequency of accidents, reducing the severity of accidents, reducing congestion due to incidents and enhancing traveler security.

In order to reduce the time and cost of implementing such a system, existing communications services will be used to the extent possible, provided they can meet ITS requirements. Some systems will require wireless data communications technologies such as dedicated short range communications (DSRC using roadside readers and vehicular mounted transponders) or may require the use of collision avoidance radar. There are likely to be ITS-specific systems or applications requiring new spectrum.

The relationship between ITS and public safety has several aspects including: the safety of the traveler and the safety of public safety personnel performing mission related functions.

4.6.3 Operational Needs. Public Safety features of the Intelligent Transportation Systems network:

- Emergency vehicle location tracking
- Emergency vehicle route guidance
- Emergency vehicle signal priority
- Driver and personal security
- Automatic collision notification
- En-route driver information
- In-vehicle signing
- Incident detection and management
- Probe data for traffic control
- Transit management
- Priority treatment for transit
- Public travel security
- Automated roadside inspections
- Weight in motion
- Automated vehicle classification
- International border crossings
- Electronic clearance
- On-board safety monitoring
- Hazardous materials incident response
- Collision avoidance
- Intersection collision avoidance
- Safety readiness
- Pre-crash restraint deployment
- Automated highway system check-in
- Highway-rail intersection safety

4.6.4 Descriptions of each Typical Operational Requirement

Emergency vehicle location tracking: Wireless data communications will be used to collect position-location information and data from emergency vehicles to improve the monitoring and display of emergency vehicle locations and help dispatchers efficiently task the units that can most quickly reach an incident site.

Emergency vehicle route guidance: Route guidance information is sent via wireless data communications to direct emergency vehicles equipped with guidance and navigation displays to an incident location. Directions are provided based on real-time information collected concerning traffic conditions and road closures in developing the best route.

Emergency vehicle signal priority: Signal priority uses wireless data communications to clear traffic signals in an emergency vehicle's route. In order to facilitate speedy movement for emergency vehicles, the vehicle can (with the help of an "onboard transceiver") alter the timing of traffic signals in the immediate vicinity (via the "fixed reader" mounted beside the traffic lights) to generate a "green wave" (a series of green signal lights in the desired direction of travel).

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Automatic Vehicle Classification (AVC): In-pavement sensors, in conjunction with the roadside wireless data transceivers (and, perhaps, an inspection facility computer), are used to count the number of axles of a commercial vehicle for classification, and match the data with the vehicle.

International border crossing: Using automated vehicle identification (AVI), commercial vehicles are identified via wireless data transmission to a roadside reader and matched to its Pre-cleared credentials, allowing the vehicle to proceed without stopping. This service enables the carriers to Pre-clear vehicles at international border crossings. Automating this process implies cooperation of registration, fuel tax, immigration, safety enforcement, and customs agencies, as well as the state transportation agencies.

Electronic clearance: A wireless data communications system would be used to identify a commercial vehicle and its electronic credentials would be verified automatically while the vehicle is traveling past the roadside reader at highway speeds. This would allow commercial vehicles to travel across state borders without being stopped for verification of paperwork and permits regarding fuel usage and tax, registration, safety clearance, etc. Combined with the networking infrastructure, which would connect roadside readers to central databases and administration centers, this service will facilitate state tax report preparation, auditing, and insurance requirements.

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Hazardous materials incident response: The safety of shipments of hazardous materials is enhanced by providing enforcement and response teams information from the vehicle via wireless data communications on the nature and location of any incident, and the type of material involved in order to enable safe and efficient response.

Collision avoidance: Radar is used to provide crash warnings and some degree of vehicle control for lane changes, road departures, and potential or impending collisions. It will help reduce the number of longitudinal and lateral collisions involving two or more vehicles, and crashes involving a single vehicle leaving the roadway.

Intersection Collision Avoidance: Drivers are warned of imminent collisions when approaching or crossing an intersection that has traffic control (e.g., stop signs or traffic signals). This application uses wireless data communications at the various arms of an intersection to sense the speed and direction of passing vehicles, which in turn, is coordinated by a roadside processor (or master reader for that intersection). Appropriate messages are dynamically transmitted to vehicles warning them of a potential collision.

Safety readiness: Radar equipment onboard the vehicle will be used to detect unsafe road conditions, such as bridge icing and standing water on a roadway, and provide warnings to the driver.

Pre-crash restraint deployment: Radar identifies the velocity and direction of vehicles and objects involved in a potential crash. Responses include tightening lap-shoulder belts, arming and deploying air bags at an optimal pressure, and deploying roll bars.

Automated highway system (AHS) check-in: Automated check-in using wireless data communications between the roadside and the vehicle at the entrance of (AHS) lanes will be used to examine lane-worthiness of a vehicle by verifying qualifying credentials for the vehicle, driver and carrier on their safety ratings and status. This ensures that both the driver and vehicle have passed the necessary safety checks to travel on automated highways.

Highway-rail intersection safety: Vehicle Proximity Alerting Systems (VPAS) will use wireless communications to provide warning messages to vehicles concerning the approach of trains at highway-rail intersections.

5.6 TRANSPORTATION

Federal activities in aviation, maritime, highways, and railroads have a tremendous investment in both fixed and mobile operations. Aviation-sector land mobile applications include maintenance, safety, and inspection using portable and mobile radios, and repeater and base station facilities; remote maintenance monitoring equipment; airport runway light control systems and wind shear alert systems. These systems are installed in airports and airway facilities for management and coordination activities. The systems use both voice and data to: automate equipment monitoring; perform safety-of-life, anti-terrorist, and air security functions; integrate air traffic control communications within the centers and control towers; and conduct various airport and airfield communications.

Federal surface transportation operations provide a variety of management and oversight support to coordinate activities at various highway and rail sites. The Intermodal Surface Transportation Efficiency Act (ISTEA) was passed by Congress and approved by the President in December 1991. It enabled the establishment of the Intelligent Transportation Systems (ITS) program. Several goals of the ISTEA are addressed in the ITS program, including: (1) the enhancement of the capacity, efficiency, and safety of the highway system, serving as an alternative to additional physical capacity; (2) the enhancement of efforts to attain air quality goals established by the clean air act; and (3) the reduction of societal, economic, and environmental costs associated with traffic congestion. The relationship between ITS and public safety encompasses several aspects concerning not only the safety of the traveler, but the array of new technologies and services that will be available to both personally owned vehicles as well as vehicles owned and operated by emergency service providers and traditional public safety agencies.

Public safety goals of the ISTEA legislation being addressed by ITS are reducing the frequency of accidents, reducing the severity of accidents, reducing congestion due to incidents and enhancing traveler security. Technology being deployed by ITS will enable these goals to be met by performing the following safety-related functions described in the ITS National Program Plan: improving on-board system monitoring, reducing the number of impaired drivers, enhancing driver performance, enhancing vehicle control capability, improving traffic safety law enforcement, smoothing traffic flows, improving emergency and roadway services responsiveness, improving passenger protection, improving response to hazardous materials (HAZMAT) incidents, improving incident management, improving incident information to drivers, improving the availability of communications devices, reducing vehicle theft, and increased monitoring of transportation facilities.

Maritime safety and waterway management agencies within the Federal Government provide for the safe operation of the Nation's navigable water resources. It requires coordination of many diverse, yet interrelated disciplines. From inspection of user vessels and offshore facilities, to provision of icebreaking capabilities to keep shipping routes open year-round, to ensuring port security, many tasks must be performed to ensure seamless utilization of coastal and inland waterways. In addition, safe passage is promoted through waterway management involving the interrelationship between vessels, waterway authorities, and facilities including docks, bridges, and piers. Finally, a key link in ensuring maritime safety results from continuous monitoring of maritime radio emergency channels, and the broadcast of maritime safety information.

5.6.1 Voice Requirements

In general, voice requirements for Federal Transportation services are similar to other Federal agencies. Immediate or near-immediate voice communications is an absolute necessity, especially when dealing with safety-of-life/property response.

Voice communications for maritime safety and waterway management must provide connectivity for command, control, and communications of operational U.S. Coast Guard forces; ensure connectivity, compatibility and interoperability with the maritime industry, the boating public, and other Federal, state and local agencies. Supported services must include: (1) Damage and degraded service/outage reports to/from mariners, (2) notification of marine casualties, (3) dissemination of Notice to Mariners, and (4) reports of pollution incidents and coordination of responding assets.

5.6.2 Data Requirements

Basic data requirements for Maritime Safety and Waterway management include clear, immediate transfer of information in support of both routine and emergency operations. Examples of required services include: (1) short range aids to navigation, (2) acquisition of vessel position, identification, and sailing intentions, and (3) data dissemination with respect to ice conditions and/or port status.

ITS by its very nature, is totally dependent on mobile communications in order to provide most of the user services. ITS frequencies must fit several criteria, among which are good propagation characteristics for the function being performed, adequate bandwidth, freedom from harmful interference, availability of low-cost components, and minimal regulatory restrictions.

There are three basic ways to provide the connectivity that is needed for ITS: (1) through the use of existing communications facilities (e.g. cellular radio, enhanced specialized mobile radio (ESMR), existing dispatch systems); (2) through new services within current spectrum allocations (e.g. high-speed data subcarriers on broadcast FM radio); or, (3) through dedicated facilities with new spectrum, which includes cases where current allocations are inadequate and where new spectrum is required to meet growth demands (e.g. electronic toll and traffic management (ETTM)).

To the maximum possible extent, the USDOT has emphasized the appropriate use of the first two alternatives. However, dedicated spectrum may be needed to support critical public safety and warning services where reliability, accessibility and liability are primary issues.

5.6.3 Video Requirements

Video requirements for Transportation management may include real-time situation updates from on-scene units to command centers. Multiple agencies may need to have the capability of monitoring another agency's video transmissions, however this capability must be controlled through a need to know or incident management process.

INTELLIGENT TRANSPORTATION SYSTEMS:

INTEROPERABILITY REQUIREMENTS

The following is material submitted to the PSWAC Interoperability Subcommittee, and contained in its final report, that addresses Intelligent Transportation Systems (ITS). This material was generated in large part, commented on, and edited by, the USDOT Joint Program Office for ITS.

1. Introduction

The relationship between ITS and public safety has several aspects including the safety of the traveler, whether on public or private vehicles and the array of new technologies and services that will be available to personally owned vehicles as well as vehicles owned and operated by emergency service providers and traditional public safety agencies. The ITS user services involve the use of in-vehicle electronics as well as roadside and other types of electronic communications systems. There will also be a mix of procurement, installation, and operation of systems by state and local governments, and fee-for-service functions provided by private service providers. Existing communications services and equipment will be used provided they can meet ITS requirements. The decision on which system is chosen will be made by the implementing jurisdiction. Information requiring wide-area distribution will require either broadcast (e.g. FM subcarrier) or two-way wide area wireless systems (e.g. data over cellular radio, PCS, or an agency ͅs privately owned system). Some ITS services (for example, most of the commercial vehicle safety-related functions) will require dedicated short range communications (such as microwave systems that use roadside readers and vehicular mounted transponders). Other safety-related functions may require the use of systems such as collision avoidance radar.

One of the functions of ITS is to collect and provide information on real time traffic conditions. Traffic control and incident response decisions are made based on analysis of the data. Since ITS may cover multiple jurisdictions, the information must be distributed quickly to multiple agencies and field units. The public safety community must develop ways to allow the seamless transfer of data among organizations. Institutional agreements on distribution and use of information among agencies and organizations must be developed in parallel with technological advances.

2. Two Categories of ITS Interoperability

The issue of wireless communications interoperability for Intelligent Transportation

Systems should be focused on two major categories:

2.1 Interagency Interoperability: Interoperability among Traffic Management Centers (TMCs), Emergency Management Centers, and deployed public safety and public service personnel is needed. These agencies need connectivity with all other public safety agencies that can provide or need access to traffic flow, incident detection and response, emergency response and safety-related information. In most cases, multiple centers are in operation within a geographical region and inter-jurisdictional cooperation is necessary.

2.2 ITS Device Interoperability: Public safety mobile units need direct access to ITS related information on a nationwide basis using either the primary radio system deployed by public safety organizations or by procuring multiple communications equipment. The key issue is how public safety field units will exchange data with numerous ITS information sources without purchasing different equipment for each system for each region of operation.

3 Interagency Interoperability

3.1 Interoperability between traffic management centers and other public safety agencies will be a mutually beneficial relationship. Traffic management centers will benefit by receiving real time traffic and incident information from public safety mobile units. Public safety and public service agencies will use ITS data to improve incident detection/response time and to aid in law enforcement. Public Safety agencies will also benefit from being able to make traffic control recommendations during incidents.

3.2 One of the goals of the traffic management centers is to improve traffic flow and reduce congestion. In order to meet this goal, the traffic control agencies need real-time data from incidents that will disrupt normal traffic patterns. While some of this data can be provided by ITS devices (such as video detection units), an additional source will be data supplied by field deployed public safety units. A consistent, automated path for funneling this information from the field to the traffic management centers is needed.

3.3 Other public safety organizations will benefit if relevant information collected by the traffic management centers can be forwarded to the agencies responsible for incident and emergency response. This will allow the responding agencies to maximize the efficiency and expediency of their response.

3.4 Key Issue: Do public safety field units need a direct communication channel with traffic management centers? Field units need to provide incident data to the traffic management centers. Traffic management centers need to provide information on incidents, traffic control decisions, road hazards etc., to public safety field units. What is the most effective means of transferring this information?

4 Day-to-Day Interoperability Requirements of ITS User Services

The following sections detail the ITS user services listed in the "ITS and Public Safety Wireless Services " report and the operational requirements from the Operational Requirements Subcommittee report that would benefit from day-to-day interoperability with public safety communications systems.

4.1 Automatic Collision Notification; Driver and Personal Security: These systems will be used to notify monitoring organizations that an incident or collision has occurred. A RF data channel is needed from private vehicles and public transit vehicles to a network access point for the monitoring organization. If a public safety response is warranted, the appropriate agencies must be notified. Since the vehicle could be moving during the incident, a RF data channel is needed to provide incident location information to the responding public safety units. The key requirement for this process will be an automated, electronic transfer function for routing the data from the monitoring agency to the public safety agencies. The data must be in a format that the public safety agencies can immediately transmit to their field units.

4.2 Enroute Driver Information; Incident Detection: These systems will be used to inform drivers with in-vehicle ITS equipment of relevant traffic conditions. Traffic management agencies need access to real time incident, weather, and traffic data so drivers can be notified. A source of information will be field reports over voice and data channels from public safety units. Network connections will be used to transfer the field data to traffic management centers. Drivers of public safety vehicles will need to receive the notifications expeditiously over various communications links.

4.3 Emergency Vehicle Route Guidance: This service will have a function similar to Enroute Driver Information. In order for the system to be successful, accurate, real time incident data must be available to traffic management agencies, and efficient routing information must be provided to drivers of public safety vehicles.

4.4 Emergency Vehicle Signal Priority; Priority Treatment for Transit: This service will enable adjustments to be made to traffic control devices to maximize the efficiency of the transportation systems, minimize response time by emergency service providers, and aid in law enforcement. Traffic management will need real-time incident data in a format that can be processed by traffic control decision-making systems. Traffic management agencies will also collect requests for traffic control that public safety vehicles and transit vehicles will need. Devices that allow direct traffic signal pre-emption from a public safety vehicle may be required.

4.5 Public Travel Security: Alarm systems installed in transit stations, bus stops, and public transit vehicles will be monitored by private or public agencies depending on the location and scope of the system. Private agencies will need a communications path to notify public safety agencies when assistance is required.

4.6 On-board Safety Monitoring: Data monitoring and communications systems onboard commercial vehicles collect safety data pertaining to critical vehicle components, condition of the cargo, and the fitness of the driver. Law enforcement officials need to be notified of the vehicle, its location, and the nature of any safety violation requiring attention.

5. Mutual Aid Interoperability Requirements of ITS User Services

The following sections detail the ITS user services listed in the "ITS and Public Safety Wireless Services " report and the operational requirements from the Operational Requirements Subcommittee report that would benefit from mutual aid interoperability with public safety communications systems.

5.1 Route Guidance and Enroute Driver Information: Incident liaison officers will need to provide incident data to the traffic management agencies. The incident commander may make recommendations on data that drivers should receive. RF data, voice, and video channels will be needed to connect the liaison officer to the traffic management center.

5.2 Incident Detection and Management: Data, voice, and video connectivity via RF channels are required between the incident liaison officer and the TMC. The TMC will be making decisions about wide area traffic flow while the incident commander makes decisions at the site of the incident. These decisions need to be closely coordinated.

5.3 Traffic Control: Data and voice RF connectivity are required between the incident liaison officer and the TMC. The incident commander needs to be informed of traffic control decisions made at the TMC that impact the area of operations. The incident commander also needs the ability to request specific traffic control measures be taken.

5.4 Enroute Transit Information: The incident liaison officer will need to provide incident data to the transit management centers and traffic management centers. The incident commander may make recommendations on data transmitted to transit vehicles. Voice and data channels are required between the incident liaison officer and the agency controlling transit information.

5.5 Public Transportation Management: System operators will need accurate information from the incident liaison officer to verify that management recommendations produced the desired effects. Voice and data connectivity is required. The incident commander needs the capability to dispatch these vehicles if large scale evacuations are required. This will